

Notes on some South African Fleas (Siphonaptera)

by

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INTRODUCTION

During a revision of the slide-collection of Siphonaptera at the South African Institute for Medical Research, special attention was directed to some questions not entirely solved by De Meillon, Davis and Hardy (1961) whose book is actually based on the specimens of this collection. The great difficulties these problems present rendered it impossible to attain completely satisfactory solutions. In some cases, however, it was thought worthwhile to give a more detailed account of the material and it is hoped that some remarks on this aspect will prove useful to other workers.

I. DISTINGUISHING CHARACTERS IN *CHIASTOPSYLLA NUMAE* (ROTHSCHILD, 1904) AND *C. ROSSI* (WATERSTON, 1909)

The difficulties in distinguishing these two species ¹⁾ from one another are caused by their great variability, the ranges of both to some extent overlapping. For this reason De Meillon *et al.* (1961) virtually put them into synonymy, retaining only some peculiar females from Namaqualand (and southwards to Klaver) as "*Chiastopsylla numae* form *typica*" and applying the name "*C. numae* form *rossi*" to the other females and to all males. Apart from nomenclatural inconveniences (the holotype of *numae* is a male) it seems that the conception of the two forms was erroneous, as females from near the type locality of *numae* and very similar to the type series (judging from fig. 654 in Hopkins and Rothschild, 1956) were identified by De Meillon *et al.* (1961) as "form *rossi*".

As already stated by De Meillon *et al.* (1961) *numae* occurs chiefly on *Parotomys brantsi* A. Smith. In order to clear up the problem, nearly all specimens of the *numae/rossi* complex in the collection of the South African Institute for Medical Research which had been collected from *Parotomys* ²⁾ were examined and a

¹⁾ In agreement with Hopkins and Rothschild (1956) *C. numae klaveriana* De Meillon, 1940, is considered as being synonymous with *numae*, and *C. crassus* De Meillon, 1940, and *C. caffrica* De Meillon, 1940, with *rossi*.

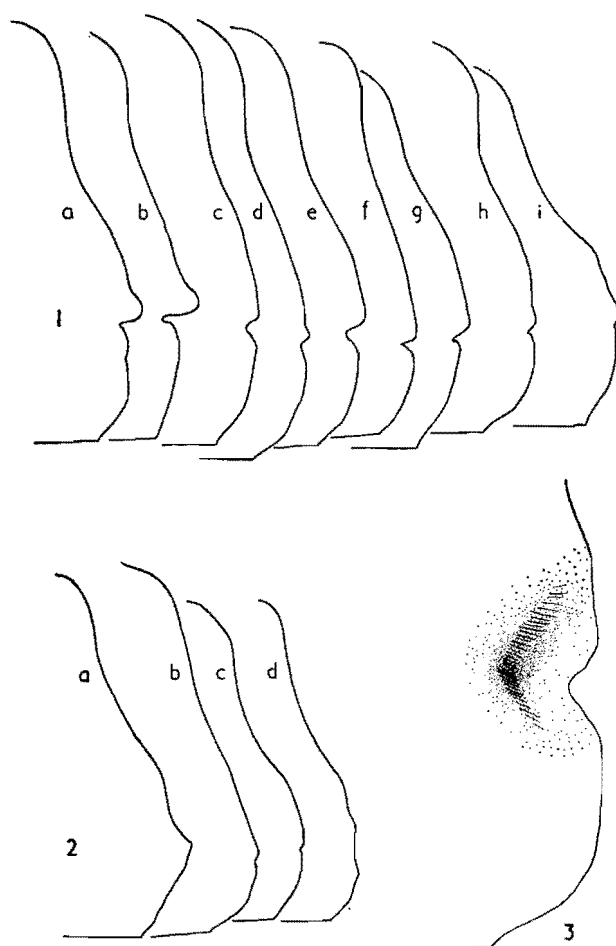
²⁾ For these hosts the identification to the species level is often missing, as the burrows and nests of *P. brantsi* and *P. littledalei* Thomas, in which most of the fleas were caught, are virtually indistinguishable from one another.

considerable number of them mounted on slides. In addition some samples from other hosts found in close proximity to those from *Parotomys* were similarly treated. This study revealed the diagnostic characters given by Hopkins and Rothschild (1956) to be completely correct, allowing the identification of all specimens with only a few exceptions, most of which are certainly freaks which are especially common in this genus. The much more extensive material studied here permits the more detailed working out of these criteria, which may be useful in cases of doubt. Nevertheless, it must be emphasized that this treatment is merely an attempt to reach a more satisfactory solution to the problem. The overlapping of the ranges of variation in the two species, though it does not occur in the same area, imposes a question which cannot as yet be solved.

MALES of *numae* are not very variable and their terminalia nearly always coincide well with fig. 653 in Hopkins and Rothschild (1956) and pl. 29., fig 9*) in De Meillon *et al.* (1961), the best diagnostic feature being the character of the scale-like setae of st. IX which are not very dissimilar from one another in size or shape. In the area of *numae* (the Karoo in its broadest sense) and also further eastwards (Transkei, Basutoland, Natal) males of *rossi* are rather uniform too, easily distinguished from *numae* especially by the very broad uppermost modified seta of st. IX (De Meillon *et al.*, 1961, pl. 29, fig. 1). In the north-eastern range of *rossi*, however, particularly in the Transvaal, the said setae are not so dissimilar in size and shape from one another (*loc. cit.*, pl. 29, figs. 3, 6, 8; see also Hopkins and Rothschild, 1956, figs. 655-7) and some specimens from Onderstepoort and the Kruger National Park are virtually indistinguishable from males of *numae*.

FEMALES of the two species are separable by the shape of the posterior margin of st. VII, which is generally distinguished by a small sinus in *numae* and a more or less projecting lobe in *rossi*. This character, however, is very variable and in both species (though more often in *rossi*) specimens occur with the posterior margin of st. VII quite smooth. Females of *numae* from the western part of its range, especially Namaqualand, usually show a very distinct sinus with a small, slightly projecting lobe dorsal to it (De Meillon *et al.*, 1961., pl. 29, figs. 10, 11; only these specimens are recognized as "*numae* form *typica*" by the authors quoted). In other localities, as in the type locality Deelfontein (Hopkins and Rothschild, 1956, fig. 654) the sinus is less conspicuous and may even be absent (fig. 1). In these cases vestiges of the sinus usually remain in the nature of the fine surface sculpture and pigmentation of st. VII. The more constant of these consists of a diffuse reddish-brown mark of stronger sclerotization found proximal to the sinus, which is possibly absent only in overcleared specimens. Additionally, in by far the majority of the specimens, a row of extremely fine striae occurs mainly

*) This fig. is actually drawn from a specimen of *numae* and not of *rossi*. The chaetotaxy of the movable process of the clasper is inaccurate. The great differences between figs. 1 and 9 on pl. 29 in De Meillon *et al.* (1961) in respect of the shape of the clasper, especially its movable process, show the extent of the variability of these features, both drawings representing the great extremes occurring. The stouter type of movable process (as in fig. 9) is generally commoner in *numae* than in *rossi*, where, however, this process is only exceptionally quite as slender as in fig. 1.



Figs. 1-3. 1. *Chiastopsylla numae* (Rothschild), posterior margin of st. VII of females: (a) Port Nolloth; (b) Klaver; (c) Beaufort West; (d, e) Prince Albert; (f, g) Loxton; (h, i) Vosburg; all in Cape Province. 2. *C. rossi* (Waterston), posterior margin of st. VII of four females from Onderstepoort near Pretoria (Tvl.). 3. *C. numae* (Rothschild), part of st. VII of female; Hanover (C.P.).

on this mark and follows a course proximal to and roughly parallel with that of the sinus (fig. 3). These features are never found in the same pattern in *rossi*, though in some females if this species a few striae, not placed in a row, occur proximally to the lobe and directed towards it.

In *rossi* the lobe of the posterior margin of st. VII is usually well developed, especially in most of the specimens from the western and southern range of the species. In the eastern parts of the Karoo, however, and north-eastwards from there, many specimens are found with the posterior margin quite smooth (De Meillon *et al.*, 1961, pl. 29, fig. 5; Hopkins and Rothschild, 1956, fig. 659) or, as occasionally in a series from Onderstepoort near Pretoria, even with a small sinus (fig. 2). The obscure mark and the row of striae proximal to the sinus are always absent in these specimens.

The material examined shows *numae* to be confined to *Parotomys* (perhaps mainly *P. brantsi*) where, as is usual in the genus, it has been found principally in the nests. It is by no means a rare species and some of the samples include numerous specimens. *Rossi*, on the other hand, is only found accidentally on *Parotomys*, its main hosts being *Rhabdomys pumilio* (Sparrman), *Otomys irroratus* (Brants), *O. unisulcatus* Cuvier and *Tatera brantsi* (A. Smith). Many other Muridae are less commonly infested and a list of them has been given by De Meillon *et al.* (1961) where, however, *Parotomys brantsi* is to be omitted. The host specificity of *numae* can best be shown by the fact that in the material examined for this study 265 males and 393 females have been collected from *Parotomys* against 11 males and 10 females from *Desmodillus auricularis* (A. Smith), nine males and 16 females from *Otomys unisulcatus* Cuvier, one male and one female from *Mystromys albicaudatus* (A. Smith) and one male and one female from *Suricata suricatta* (Schreber). In contrast only two females among at least 1000 specimens of *rossi* were taken from *Parotomys*.

The distribution of the two species expresses this host relationship very clearly, *numae* being found only within the range of *Parotomys brantsi*, i.e. in the Karoo in the broadest sense, including the country near the west of South Africa. It has not been collected far north of the Orange River (but this may be due to insufficient collecting) and its distribution extends north-eastwards to Luckhoff in the Orange Free State, where according to Acocks (1953) a tongue of Karoo vegetation points towards the east. In accordance with the more extensive host range of *rossi* this species is able to inhabit country of a much more varied type. It is, therefore, distributed throughout nearly the whole of South Africa, apparently still more common in areas of grassveld than in the Karoo and the south western Cape, and is only rare along the warmer parts of the south-east coast and in the eastern lowveld. A few specimens have also been collected in Southern Rhodesia (De Meillon *et al.*, 1961, map 21).*)

*) Some of the localities for *rossi* in the Karoo marked on the authors' map actually refer to *numae*. A revision of all the material (some 10,000 specimens) was impossible and it was, therefore, not expedient to draw a new map. As *numae* occurs in nearly the whole range of *Parotomys brantsi* (Davis, 1962, map 8) and *rossi* is probably present in all these localities too, there seems to be no urgent need for a detailed account of the places where these common fleas have been collected.

The very close morphological resemblance between *numae* and *rossi* and the clear-cut ecological differences between them suggest that both may be only subspecies. But with the great taxonomic difficulties encountered nearly everywhere in *Chiaestopsylla* any unnecessary change in the status of one of its members should be avoided. Therefore it is thought best to consider *numae* and *rossi* as full species until a thorough revision of the whole genus can be undertaken.

Unfortunately it is impossible to determine with complete certainty the status of the two species, especially of *numae*, as plague vectors. Ingram (1927a) possibly confused the two forms, though it is highly probable that he used *rossi* in his successful transmission experiments. According to Mr D. H. S. Davis (personal communication) the fleas used in the mixed-species test pools from which *Pasteurella pestis* has been isolated (De Meillon *et al.*, 1961, table 1 and p. 158) were actually *rossi*. So it seems safe to assume that this species is an effective carrier of plague from rodent to rodent, though not one of the most important. Of the status of *numae* nothing is known.

II. VARIABILITY IN *CHIASTOPSYLLA MULLERI* INGRAM, 1927

When Ingram (1927b) described *Chiaestopsylla mulleri* and its "var". (i.e. subspecies) *longisetis* he used as distinguishing criteria the length of the longest setae on the first two segments of the hind tarsus of the male and the chaetotaxy of st. VIII in the same sex. De Meillon *et al.* (1961) stated quite correctly that these characters vary independently from one another and therefore sunk *longisetis* into synonymy. They overlooked, however, that the variation in both features is a geographical one and, further, that near the west coast of South Africa specimens occur with st. VIII and other features of the ♂-terminalia differently developed from the two forms already described.

The fact that the two characters mentioned are independently variable makes it very difficult to find a taxonomic arrangement for the multitude of forms met with in *mulleri* and it is probably impossible to fit all of them quite satisfactorily into the pigeon-hole system of zoological nomenclature. In view of this, greater emphasis is laid on a clear exposition of the pattern of variability. The grouping of the different populations into subspecies is also attempted but is necessarily somewhat arbitrary and may not meet with general approval.

The characters principally investigated are: the length of the longest setae of segments 1 and 2 of the hind tarsus, the shape and chaetotaxy of st. VIII and some other features of the terminalia, all in the male. Females are virtually indistinguishable and therefore no further reference will be made to them.

The two types of tarsal setae are figured by De Meillon *et al.* (1961, pl. 35, figs. 4, 5). In the nominate subspecies, but also in some populations of both the others, the longest setae of segments 1 and 2 of the hind tarsus reach only to about the apex of segments 2 and 4 respectively. On the other hand in most specimens of *mulleri longisetis*, but again not confined to this subspecies, the seta of segment 2 extends to about the apex of segment 5 and that of segment 1 is not much shorter.

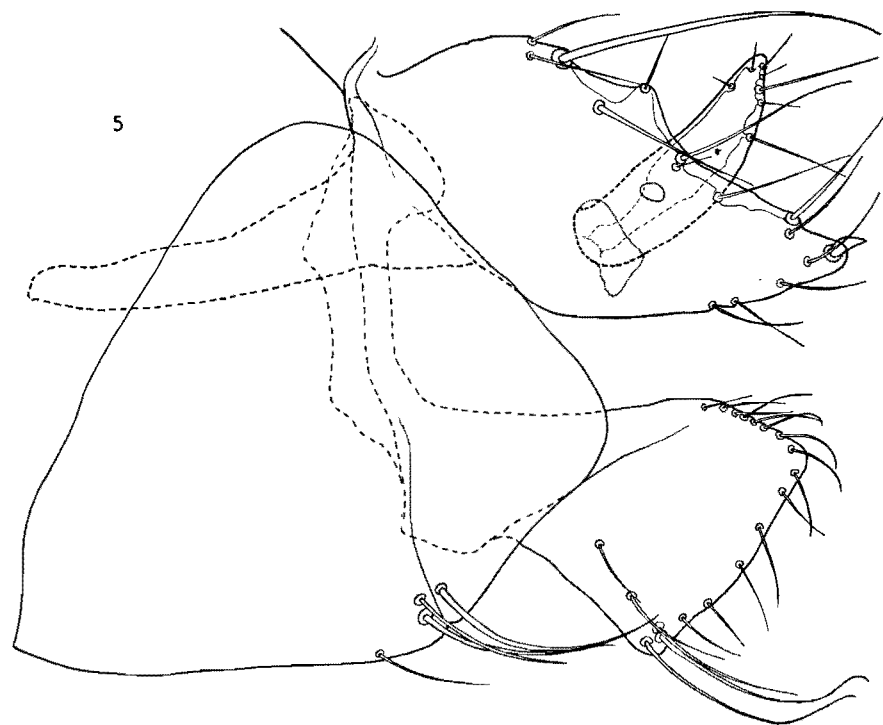
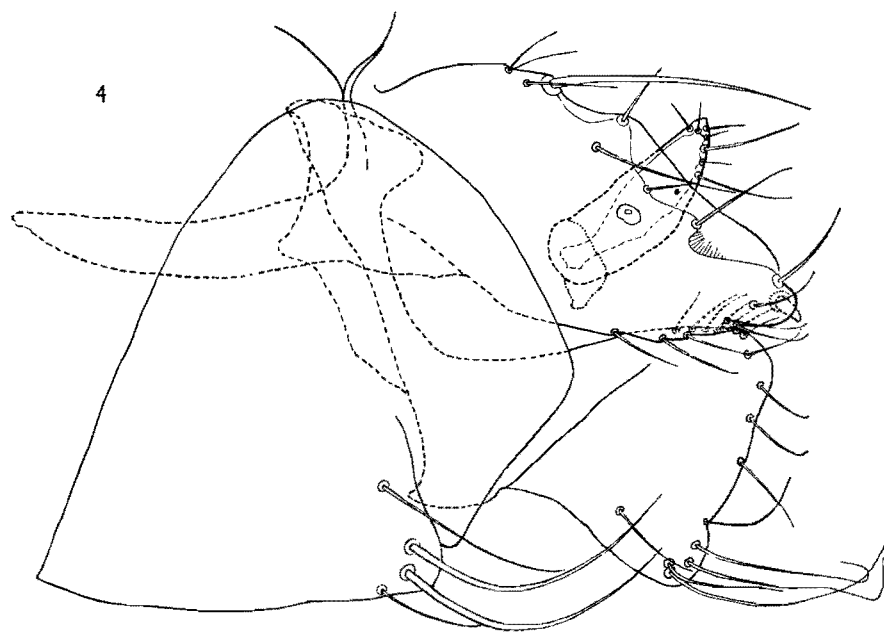
Specimens with these long tarsal setae are found in the eastern and northern parts of the Karoo and at Hondeklip Bay on the coast of Namaqualand. Populations with short tarsal setae occur in the south-western part of the area of *mulleri*, extending inland to Calvinia and northwards along the mountains to beyond Springbok, but those from Namaqualand are often intermediate in this respect. The exact distribution of the populations with the two forms of tarsal setae is shown in fig. 10, the symbols marked with a point indicating localities where specimens with short tarsal setae were recorded.

Sternum VIII in its simplest form (fig. 4) shows a well marked ventro-apical angle at a short distance from the point, indicated on both sides by a small seta which serves as a land-mark, where the posterior margins of both sides meet mid-ventrally. Shortly distad to the ventro-apical angle a small indentation is visible from which a ridge or fold runs upwards, thus partially cutting off an apical portion of the sternum. The other extreme is shown in fig. 6, where the ventro-apical angle is lost, the apical portion is much more extensive and its ventral margin continues the ventral margin of the sternum in almost the same direction. Transitions between these extremes are shown in figs. 5, 7, 8 and 9. The setae placed on st. VIII (except the small proximal one already mentioned which is rather uniform in all specimens) differ in shape according to their place of insertion. At and near the ventro-apical angle they are long, curved bristles of a quite "normal" nature. The more distally they are placed the more strongly bent, thickened and slightly flattened they become, as is clearly visible in fig. 6. The position of the setae is correlated with the differences of the shape of st. VIII, for the more strongly the apical portion of this sclerite is developed the farther distad the bristles are inserted.

The characters found on st. VIII are used here for the classification of the material. They are believed to be of much greater importance than the length of the setae of the hind tarsus which is so highly variable in some other species of the genus (e.g. *C. octavii* Rothsch.) that sometimes the two legs of one specimen differ in this respect. On the other hand the features of st. VIII are correlated (though admittedly not always strictly) with other characters of the terminalia. Furthermore the trend leading to the state shown in *mulleri longisetis* (fig. 6) finds an easy continuation in *coraxis* De Meillon (Hopkins and Rothschild, 1956, fig. 684) which has short tarsal setae, and the formation of st. VIII seems to have some bearing on the classification of the species of *Chiastoposylla* (in most species of the *numae* group the ventro-apical angle of st. VIII is greatly lengthened and distally produced thus showing the opposite extreme in the development of this sternum compared with *mulleri longisetis*, *coraxis* and *capensis* De Meillon).

EXPLANATIONS OF FIGURES

Figs. 4 and 5. *Chiastoposylla mulleri simplex* subsp. nov., terminalia (phallosome omitted) of males: 4. holotype, Hondeklip Bay, (Namaqualand, C.P.) 5. Velddrif (Malmesbury Distr., C.P.).



Chiastopsylla mulleri simplex subsp. nov., fig. 4, 5 and 7

Males considered to belong to this subspecies are distinguished by having the lower part of the posterior margin of st. VIII at a definite angle to the ventral edge of this sternum (ventro-apical angle of st. VIII well developed) and the setae being inserted near or proximal to the fold or ridge which separates an apical portion of st. VIII from its main part. Dorso-apical angle of st. IX usually rounded. As the series united under this heading differ to some extent from one another, only males of one population (Hondeklip Bay) have been designated as holotype and paratypes and these will be described first.

St. VIII as in fig. 4, all setae (usually three or four each side) placed proximally to the ventro-apical angle. Apical portion of st. VIII well demarcated from the main part by a fold and an indentation in the posterior margin. Movable process of clasper relatively stout. Dorsal margin of clasper not markedly concave in the apical half of its length, the setae which are placed near the margin in other forms of *mulleri* are separated from it by a rather broad, weakly sclerotized and feebly pigmented belt which is much narrower in all other forms and in them is mainly restricted to the intervals between the setae. Longest seta of the first segment of hind tarsus reaching beyond segment 4, that of segment 2 to about the apex of segment 5.

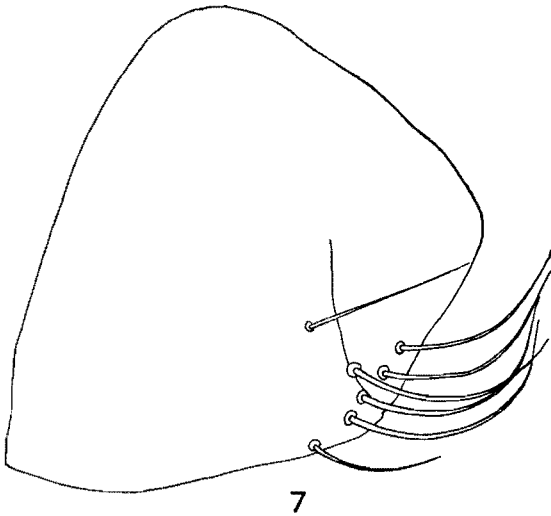
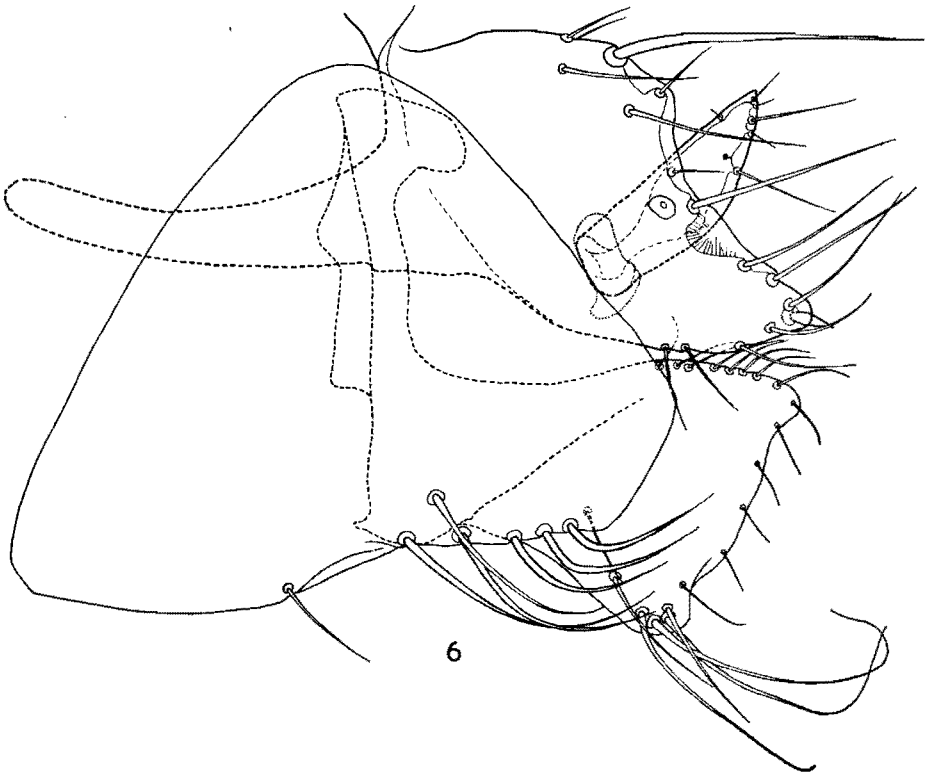
♂-Holotype: Hondeklip Bay (Namaqualand), in nest of *Otomys unisulcatus* Cuvier; 25.X.1941, leg. T. Muller; 32 ♂-paratypes: as holotype, 24 and 25.X.1941, 23 and 25.VII.1949 and 5.VI.1951, leg. C. J. Muller, and in nests of *Gerbillus paeba* A. Smith, 27.X.1941, leg. T. Muller.

Specimens from the interior of Namaqualand (in the regions of Springbok and Garies) agree completely with those from the type-locality, but have tarsal setae which are either short or intermediate in length between the two types figured by De Meillon *et al.* (1961). 17 Males from this area have been seen.

In the south-western part of the range, males are distinguished from the type series by a slenderer movable process of the clasper, by the dorsal margin of the clasper being markedly concave in the distal half of its length and by the fact that the setae of st. VIII (about three each side) are placed at the fold that separates the apical portion, which is also divided from the main part of st. VIII by a very small indentation or by none at all (fig. 5). All specimens have short tarsal setae. 49 Males of this kind have been examined, found in the Malmesbury and Piketberg districts. Four males from Van Rhynsdorp district are somewhat transitional to the northern form and obviously the material from Klaver mentioned in Hopkins and Rothschild (1956, fig. 681,; pls 29E, 30C) under *mulleri mulleri* also belongs here.

EXPLANATIONS OF FIGURES

Fig. 6. *Chiastopsylla mulleri longisetis* Ingram, terminalia (phallosome omitted) of male; Carnarvon (C.P.). Fig. 7. *C. mulleri simplex* subsp. nov.; Prieska (C.P.), st. VIII of male.



In Bushmanland, extending to beyond Prieska in the north-east, the specimens are somewhat transitional to *mulleri longisetis*, having many more setae on st. VIII (fig. 7) which, however, are all placed near the well developed ventro-apical angle thus indicating a close relationship to *simplex*. The clasper is similar to the south-western form (cf. fig. 5), but the movable process is rather stout. In ten males from Steinkopf, Okiep and near Springbok the tarsal setae are short, in the remaining 11 males from the Kenhardt, Upington and Prieska areas they are long.

Chiastopsylla mulleri mulleri Ingram, 1927, figs. 8 and 9

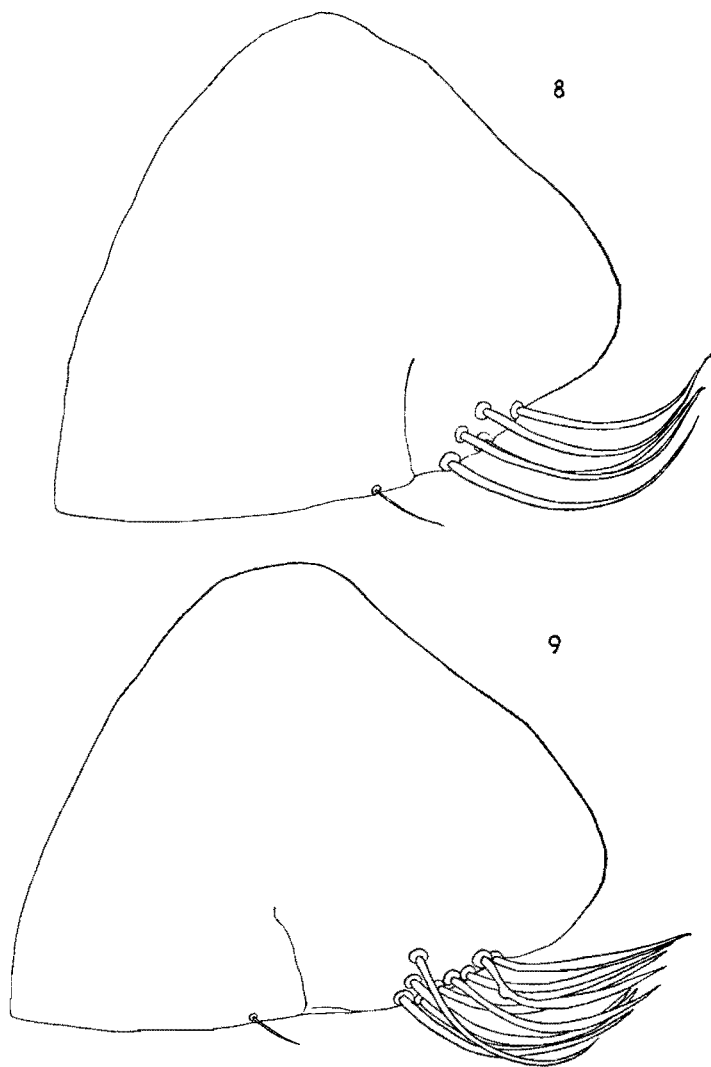
In this subspecies the apical portion of st. VIII is well developed and is separated from the main part by a weak fold, but the ventro-apical angle of the sternum is hardly indicated (fig. 8). The long setae of st. VIII are numerous and are all placed on the apical portion distal to the fold and close to one another, forming a kind of brush. Clasper and st. IX as in *m. longisetis* (cf. fig. 6), the dorsal margin of the clasper definitely concave in the distal half of its length and the dorso-apical angle of st. IX usually rather projecting. The tarsal setae are short.

Only a few series of this subspecies are known; the collection of the South African Institute for Medical Research contains 11 males from Calvinia, including a paratype (fig. 8) and six males from Doornbosch (Calvinia Distr.), in the latter the setae of st. VIII are specially numerous and form a very conspicuous brush (fig. 9).

Chiastopsylla mulleri longisetis Ingram, 1927, fig. 6

In this subspecies the apical portion of st. VIII is the most strongly developed among all known forms of *mulleri*. It is completely connected with the main part of the sternum without any indentation or dividing fold and the ventro-apical angle is entirely absent, the lower part of the posterior margin thus forming an apparent continuation of the ventral margin (fig. 6). All long setae of st. VIII are placed on the apical portion, not clustered together as in *m. mulleri* but in a mainly marginal row, the most distal of them rather strongly bent and slightly flattened. Clasper and st. IX similar to those of the nominate subspecies. Tarsal setae long (in one male from the type locality those on the first segment of the hind tarsus short, on the second segment long) except in a series of 15 males from Die Krans near Middelpost, to the south-east of Calvinia, where they are short. Besides these, 44 males from the areas of Sakrivier (type locality), Tontelbos, Vanwyksvlei, Carnarvon and Sutherland have been examined.

No ecological differences could be observed between the three subspecies. All are principally nest fleas, most common by far on *Otomys unisulcatus* Cuvier. A few specimens were also taken from *Parotomys brantsi* (A. Smith), *P. littledalei* Thomas, *Rhabdomys pumilio* (Sparrrman), *Desmodillus auricularis* (A. Smith), *Rattus namaquensis* (A. Smith) and *Gerbillus paeba* A. Smith, and a detailed account of them may be found in De Meillon *et al.* (1961: 182).



Figs. 8 and 9. St. VIII of male of *Chias topsylla m. mulleri* Ingram; 8. paratype, Calvinia (C.P.)
9. Doornbosch (Calvinia Distr., C.P.).

As already mentioned, the taxonomic arrangement chosen for the many forms and transitions may not be satisfactory. It seems possible to recognize only the species *mulleri* without further subdivision. But the two extremes, *simplex* and *longisetis*, are so far from one another (figs. 4 and 6) that some organization of the complex seems desirable. Other ways to achieve this would be to name only the extremes themselves (*longisetis* then must share the name of *mulleri*) or to establish a fourth subspecies for the populations from the south-west, which are rather different from *simplex*. The course followed here was to bring about as little nomenclatural change and to name as few new taxa as possible. It seems more important to view the transition of characters, especially in st. VIII, from the north-west to the south-east, which finds its continuation in *coraxis* which certainly belongs to the same complex as *mulleri* and may well be but a subspecies of it. The greater morphological differences between *coraxis* and *longisetis*, which have no known intergrades, indicate, however, that the speciation is much more advanced there than in the taxa treated here as subspecies of *mulleri*, and *coraxis*, therefore, is best considered as a full species.

III. VARIABILITY IN *PROCAVIOPSYLLA CREUSAE* (ROTHSCHILD, 1904) AND THE DISTINGUISHING CHARACTERS FROM *P. DIVERGENS* (JORDAN AND ROTH-SCHILD, 1908)

Procaviopsylla creusae and *P. divergens* were both described from specimens obtained at Deelfontein (C.P.). The only true host of these fleas is *Procavia capensis* (Pallas), although occasionally stragglers may be found on other animals, e.g. the type of *P. creusae* on *Felis caracal* Schreber. Females of both species are difficult to distinguish from one another and the fact that they occur together does not facilitate matters. Consequently Hopkins and Rothschild (1935: 227-30) identify the males of some of their series as *creusae*, the females as *divergens*. De Meillon *et al.* (1961: 73) even suppose *divergens* to be a probable synonym of *creusae*.

A study of the variability of *creusae* was thought to be a step towards a solution of this problem. The results obtained, however, are far from being satisfactory and many of the characters given in the following pages are more or less tentative, which is due especially to the ignorance of the variability of *divergens*, a species of which only few specimens are known.

Nearly every population of *creusae* is distinguished from others by some minor difference. As the host *Procavia capensis* usually lives in fairly isolated places (mostly rocky outcrops), this is not very surprising. This isolation has obviously had a different effect on the speciation of fleas from that of Mallophaga (especially *Procavicola*, see Hopkins, 1945). Unfortunately no information is available as to the subspecies of *Procavia capensis* from which the fleas were collected, but the mere fact that *creusae* and *divergens* occur together, already shows that here the relationship between parasite and host is of another kind than that in *Procavicola*, being far less close.

According to their geographical distribution the populations of *creusae* can be divided into several fairly distinct morphological groups, but intermediates

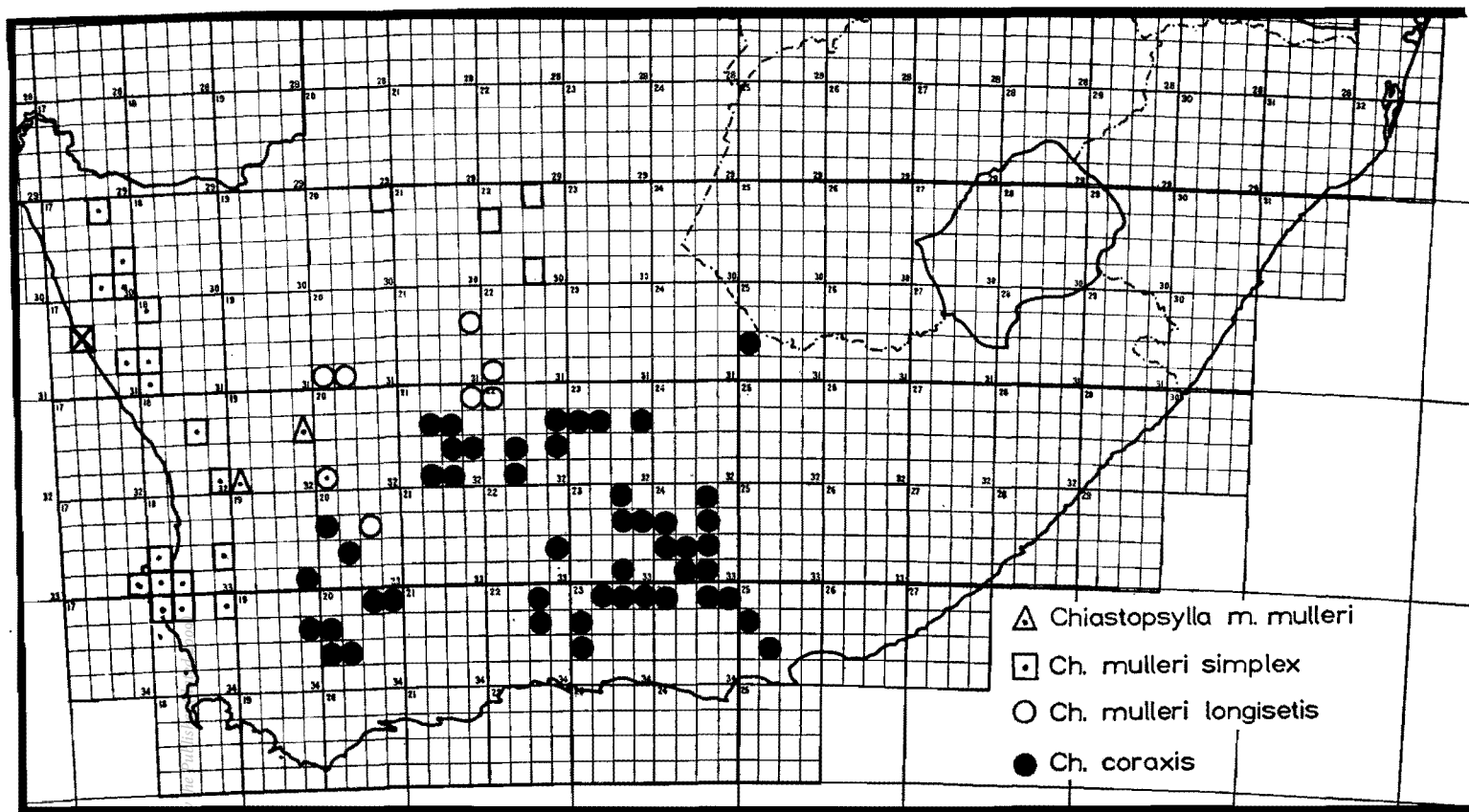


Fig. 10. Distribution of *Chiastopsylla mulleri* Ingram and *C. coraxis* De Meillon. Symbols marked with a point (.) indicate localities where specimens of *C. mulleri* occur with the longest setae on segments 1 and 2 of the hind tarsus of the male short. The type-locality of *C. mulleri simplex* subsp. nov. is indicated by a cross (x).

are not rare and still more are to be expected from areas not yet explored. An arrangement of these forms is attempted mainly by using the different lengths of the labial palpi. As this character also serves to separate *creusae* from *divergens*, difficulties arise. Nevertheless it is hoped that the criteria given to distinguish the two species are correct even for females, at least for those of them found in the Cape Province. All females from Natal are indistinguishable from one another and are usually associated with *creusae* males. As there is only one male of *divergens* known so far from this province (Ntabamhlope, Estcourt Distr.), it may be that females of this species have not yet been collected in Natal, but it is also possible that the two species are inseparable in this sex in areas where *creusae* forms with relatively long labial palpi occur. The identity of some specimens (one female, Ntabamhlope; probably mentioned as *P. divergens* by Bedford, 1932, and four females, Dargle, identified as *P. divergens* by Smit, 1955) must therefore remain doubtful until both sexes of *divergens* are found together in this area.

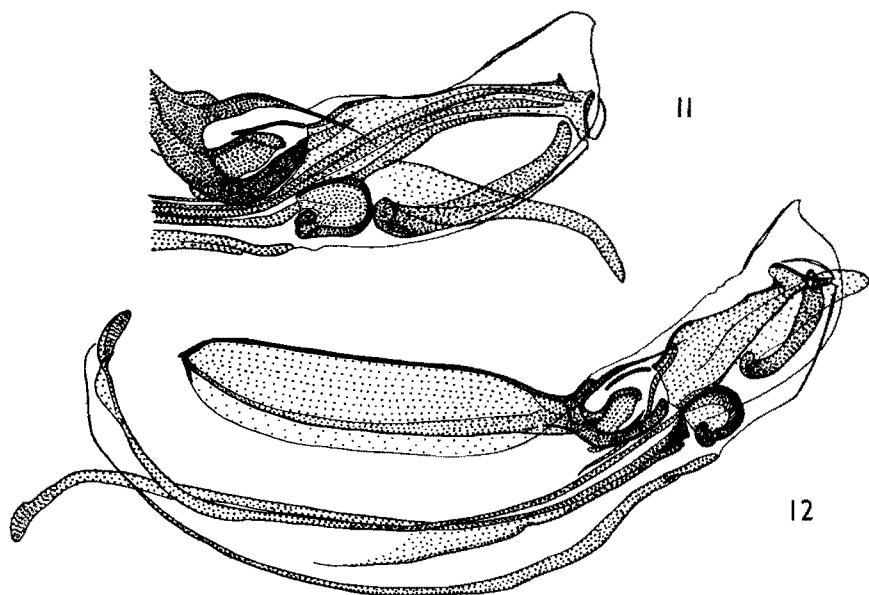


Fig. 11. *Procaviopsylla divergens* (Jordan & Rothschild), aedeagus; Loeriesfontein (Calvinia Distr., C.P.). Fig. 12. *P. creusae* (Rothschild), phallosome; Houtbay near Cape Town (C.P.).

In the concept of *divergens* and *creusae* as put forward here, the main differences between them are as follows, the characters of the ♂ genitalia being the most clear-cut and reliable ones.

Procaviopsylla divergens: *Male*: Labial palpus much longer than maxillary palpus (1.2—1.4 x).¹⁾ Crochet of phallosome strong, pointed and curved apically (fig. 11); inner tube of aedeagus rather long and narrow. St. VIII with a conspicuous membranous prominence at the apex.

Female: Labial palpus very long, reaching to the apex of fore coxa or beyond, ca. 1.4—1.5 x as long as the maxillary palpus, the latter therefore extending only to about the articulation between segments 3 and 4 of labial palpus and are usually shorter than a line from the preoral angle to the lowest seta of the main row of occiput (fig. 13).

Procaviopsylla creusae: *Male*: Labial palpus about as long as maxillary palpus or shorter. Crochet of phallosome only weakly sclerotized, broadly rounded apically and often difficult to see (fig. 12)²⁾; inner tube of aedeagus shorter and broader than in *divergens*. St. VIII without a prominence or with only an inconspicuous one.

Female: Labial palpus at most 1.3 x as long as maxillary palpus; in specimens in which the latter does not extend much beyond the last articulation of the labial palpus it is nearly always as long as or longer than a line from the preoral angle to the lowest seta on the occiput.

Some of the female characters (especially the length of the maxillary palpus in relation to the length of the head) may be subject to parallel variation in both species and might not be applicable in some specimens from other localities. Further features of females in *divergens* are perhaps due to the slightly larger size of this species and may therefore be variable, their range overlapping that of *creusae*. For instance, the falx is somewhat sclerotized in *divergens*, whereas in *creusae* it is at most weakly indicated. In both species the three or four uppermost setae in the main row of st. VIII are slightly spiniform; in *creusae* the next following seta is usually much slenderer, the transition being more gradual in *divergens*.

P. divergens has only been collected in a few places near the great escarpment of South Africa from the Natal Drakensberg to the western Karoo³⁾. *P. creusae*

¹⁾ The ratios between certain lengths mentioned were obtained by measurements from six males and three females of *divergens* and 78 males and 114 females of *creusae*. The length of the fore coxa has been measured only to the base of the three strong setae on the anterior side of the apex, the lateral lobe of the coxa not being considered.

²⁾ The "intermediate" shown by De Meillon *et al.* (1961, pl. 11, fig. 3) is actually due to an accident in mounting. The crochet of the phallosome figured there is a typical one for *creusae*, but lies longitudinally in an oblique plane, therefore appearing narrower than when flattened.

³⁾ In the legend to map 10 in De Meillon *et al.* (1961) the names "*creusae*" and "*divergens*" have been interchanged in error.

is much commoner and is found in the southern parts of South Africa from Zululand to the west coast. Over this range the many forms of this species can be provisionally divided into three major groups, though these perhaps are only arbitrary divisions of a cline.

The first of these groups comprises specimens from the Orange Free State and the adjacent part of the Cape Province, including those from the type-locality, Deelfontein. They are distinguished from other populations especially by the shortness of the maxillary and labial palpi, both ending far short of the apex of the fore coxa in both sexes. In the male the labial palpus is much shorter than the maxillary palpus, in the female it is of about equal length or slightly longer (fig. 14). St. VIII of male without a prominence.

In a second group of populations, occurring in the western Karoo, the palpi are of medium length. In the male the labial palpus is as long as the maxillary palpus or a little shorter, both not reaching to the apex of the fore coxa. St. VIII sometimes shows a small swelling at the point of insertion of the apical setae. In the female (fig. 15) the labial palpus reaches nearly to the apex of the fore coxa (0.88—1.00), the maxillary palpus being much shorter, sometimes extending not far beyond the articulation between segments 3 and 4 of the labial palpus.

Specimens from all localities between the coast and the high-lying interior of South Africa form a third large group. Their palpi are relatively long and therefore females have often been mistaken for *divergens*. In the male the maxillary and labial palpi are of about equal length, not quite reaching to the apex of the fore coxa. In the female (figs. 16, 17) the labial palpus reaches slightly beyond the apex of the coxa (1.00—1.16), the maxillary palpus being much shorter, but usually extending beyond the articulation between segments 3 and 4 of the labial palpus and generally longer than a line from the preoral angle to the lowest seta of the occiput. St. VIII of male is as in the specimens from the western Karoo except in two series from Albany, where it shows a clearly visible prominence near the apex (De Meillon *et al.*, 1961, pl. 11, fig. 3) which is, however, far less conspicuous than in *divergens*.

As already said these groups are by no means well defined and it seems unwise to distinguish them as subspecies. It is much more probable that a cline exists from the forms with short palpi near the type-locality to the populations with medium-sized palpi in the western Karoo and finally to the forms with long palpi of the territories nearer the coast. It would be very interesting to know what happens when populations with short palpi meet directly with those having long palpi as must occur near part of the great escarpment.

Specimens seen: six males and three females of *P. divergens*, 96 males and 150 females of *P. creusae*. All of them were taken from subspecies of *Procapia capensis* (Pallas) except three males and one female of *creusae* from *Rattus natalensis* (A. Smith) and one female of the same species each from *Cryptomys hottentotus* (Lesson) and *Desmodillus auricularis* (A. Smith).

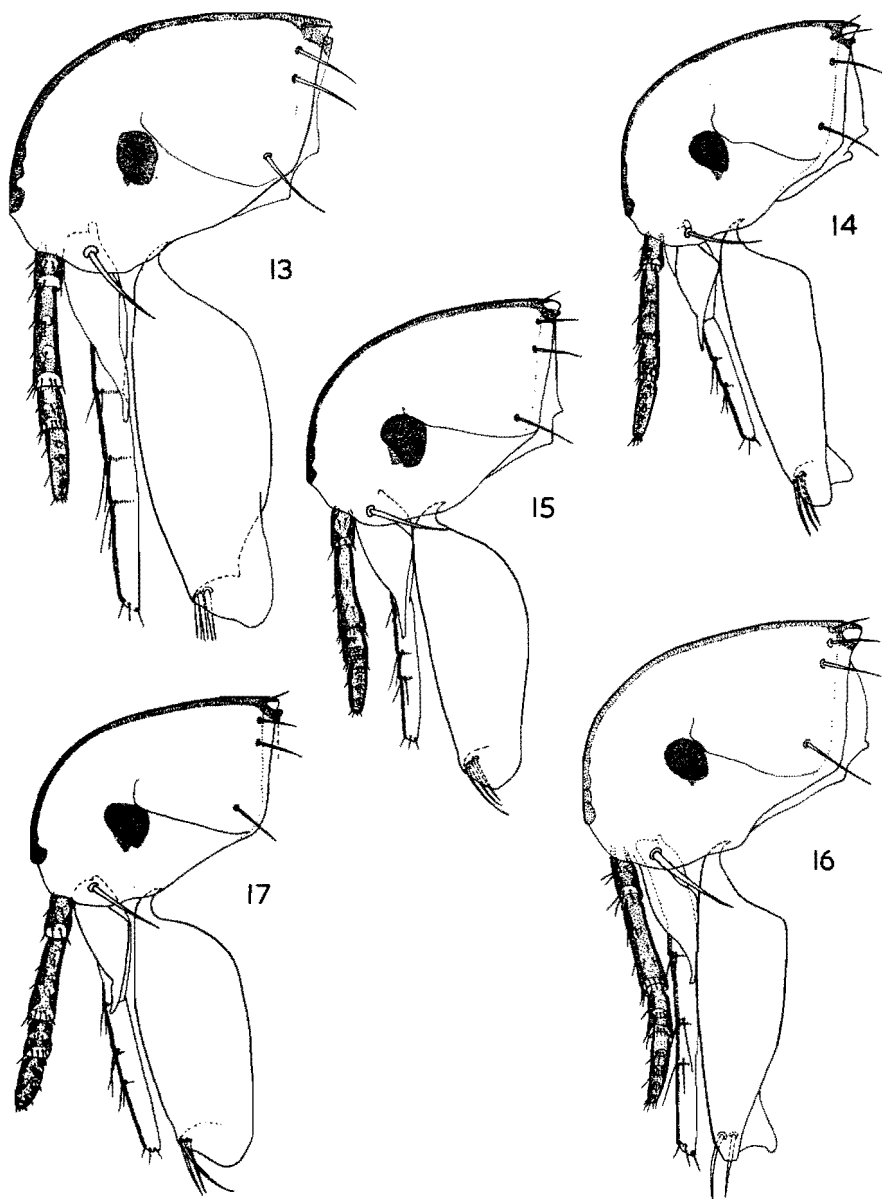


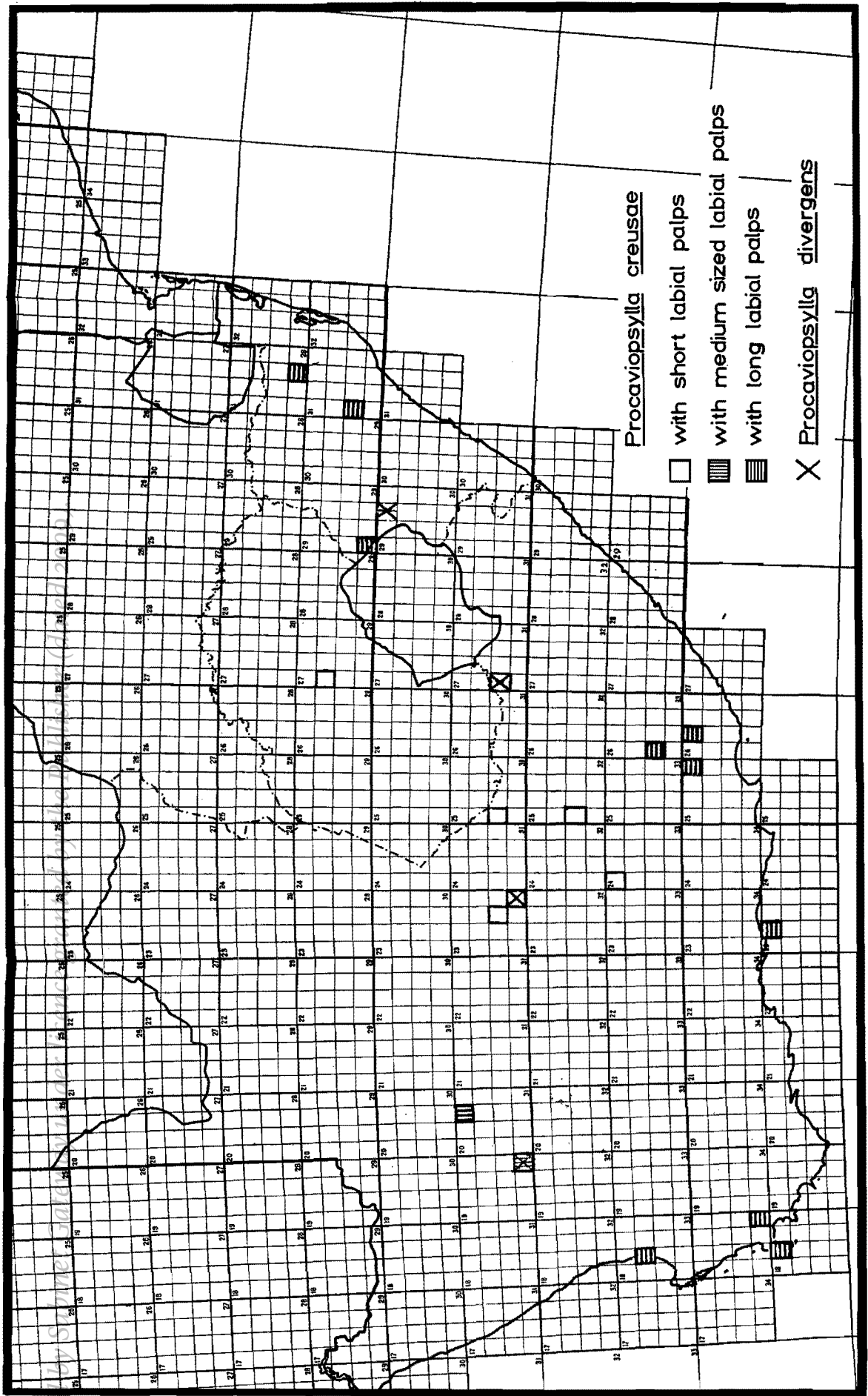
Fig. 13. *Procaviopsylla divergens* (Jordan & Rothschild), head of female, Loeriesfontein (Calvinia Distr., C.P.). Figs. 14-17. *P. creusae* (Rothschild), head of females: 14. Colesberg (C.P.); 15. Loeriesfontein (Calvinia Distr., C.P.); 16. Hout Bay near Cape Town (C.P.); 17. N'kandhla (Natal).

ACKNOWLEDGEMENTS

To Mr G. H. E. Hopkins, Tring, Herts., Dr F. Zumpt and Mr D. H. S. Davis, Johannesburg, and Mr C. G. Coetzee, Pretoria, I wish to express my sincere thanks for their kind help and encouragement in preparing this paper. I am also greatly indebted to Dr R. F. Lawrence, Pietermaritzburg, for the loan of specimens and to Mrs J. Segerman, Miss J. Walker and Mr M. Ulrich, Johannesburg, for their technical assistance. I wish to thank the Director of the South African Institute for Medical Research for facilities provided.

REFERENCES

- ACOCKS, J. P. H., 1953. Veld types of South Africa. *Mem. bot. Surv. S. Afr.* **28**, vi + 192 pp., 7 maps. Pretoria: Government Printer.
- BEDFORD, G. A. H., 1932. A synoptic check-list and host-list of the ectoparasites found on South African Mammalia, Aves and Reptilia (2nd. edition). *Rep. vet. Res. S. Afr.* **18**: 223-523.
- DAVIS, D. H. S., 1962. Distribution patterns of Southern African Muridae, with notes on some of their fossil antecedents. *Ann. Cape Prov. Mus.* **2**: 56-76.
- DE MEILLON, B., DAVIS, D. H. S. and HARDY, F., 1961. Plague in Southern Africa, vol. I. The Siphonaptera. Pretoria: Government Printer. viii + 280 pp., 36 maps.
- HOPKINS, G. H. E., 1945. Lice of the hyraxes, especially *Procavia capensis*. *J. ent. Soc. S. Afr.* **8**: 1-12.
- HOPKINS, G. H. E. and ROTHSCILD, M., 1953. An illustrated Catalogue of the Rothschild Collection of Fleas, vol. I, xvi + 361 pp., 45 plates, 1 map. London: British Museum.
- , 1956. Ibidem, vol. II, xii + 446 pp., 32 plates, 1 map.
- INGRAM, A., 1927a. Plague investigations in South Africa from an entomological aspect. *Publ. S. Afr. Inst. med. Res.* **3**: 222-56.
- , 1927b. New fleas from South African rodents. *Bull. ent. Res.* **17**: 289-93.
- SMIT, F. G. A. M., 1955. A list of the African Siphonaptera in the Natal Museum. *Ann. Natal Mus.* **13**: 211-6.



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